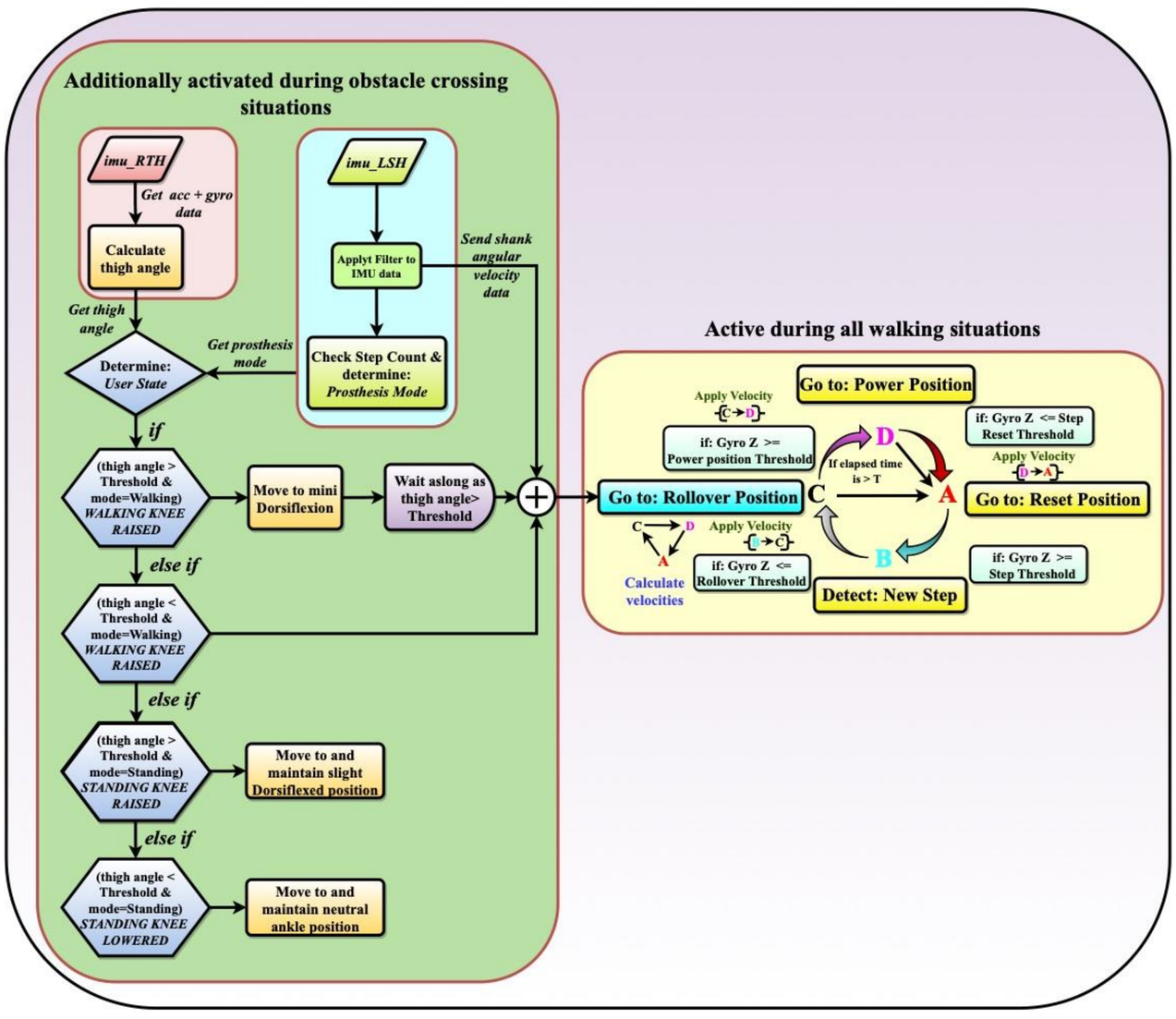
A Control Method for Transtibial Prostheses with Bilateral Leg Data

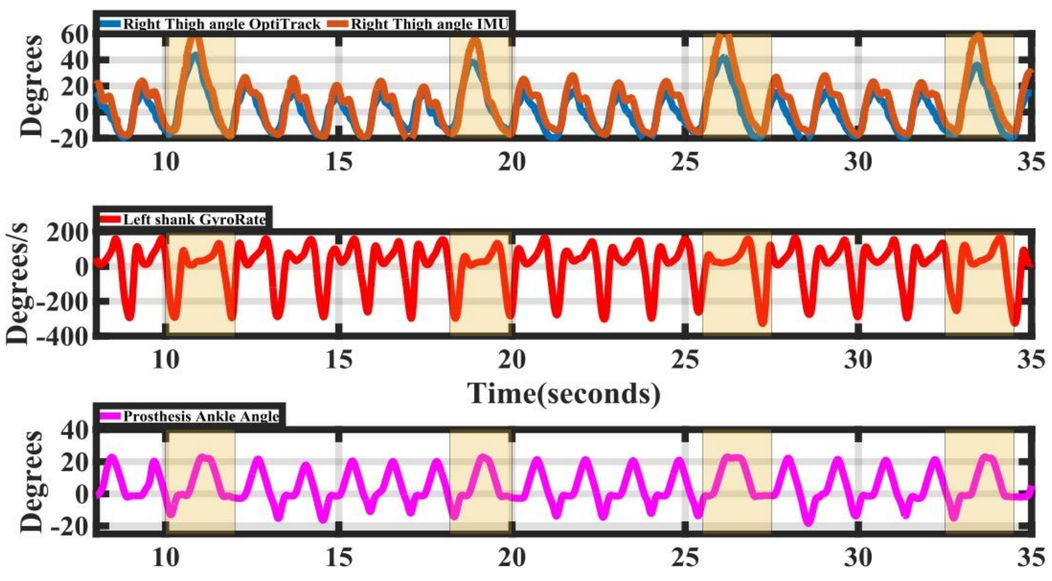
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Conventional prostheses rely on sensors from the amputated side alone, limiting gait adaptability. This study introduces a control system using just **two IMUs**—on the **left shank** and **right thigh**—to capture bilateral limb data. Control commands were generated for a table-mounted transtibial prosthesis during walking trials at varying speeds and with obstacle avoidance. Results show that **bilateral sensing improves gait state detection**, enabling **more precise and responsive prosthesis control**.

Furthermore, body-wide data collection may also improve balance with prostheses.

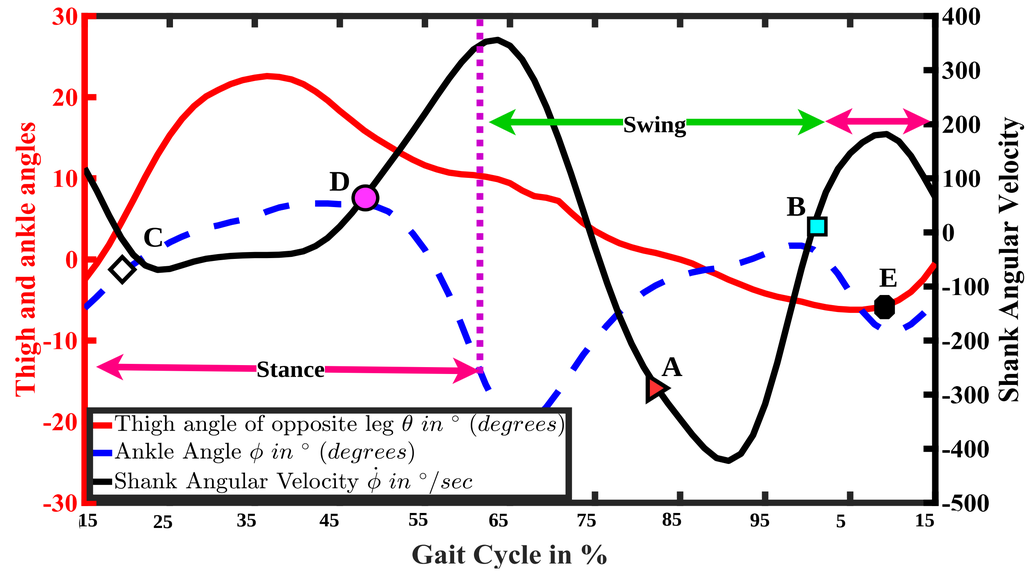


Control architecture for a transtibial prosthesis, which uses data from two IMUs to generate position profiles and actuate the prosthesis. imu RTH represents the IMU on the right thigh, whereas imu LSH represents IMU on the left shank. The green block represents the logic where the **data fusion** from both IMUs occurs, whereas the yellow block shows the **outcome** of the decisions as applied to the prosthesis. The thigh angle threshold is set at 30◦.

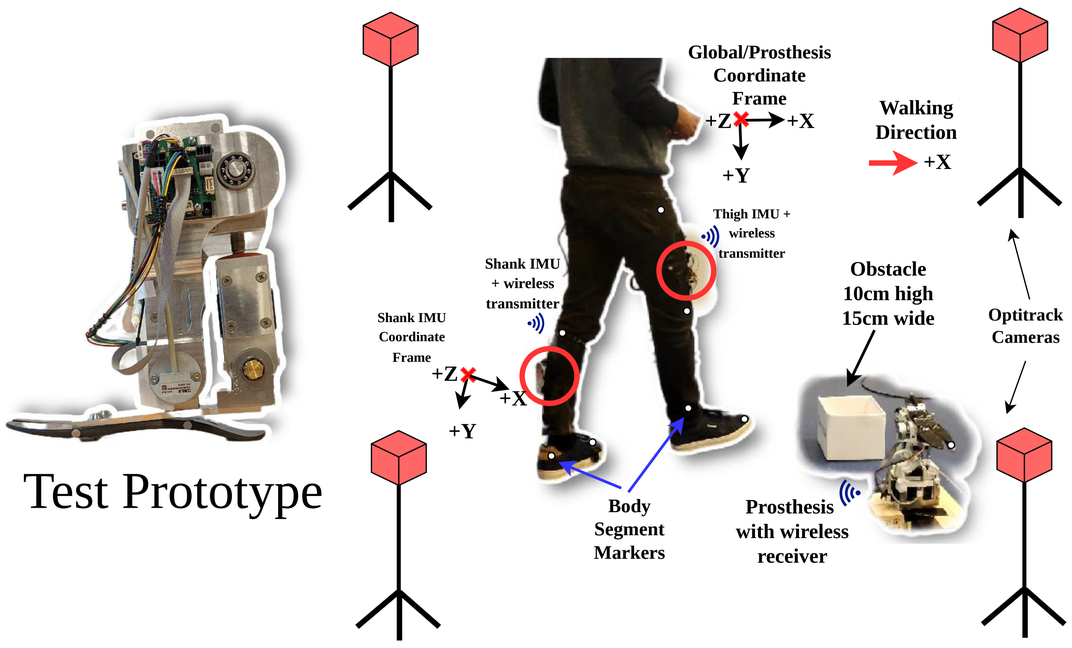


Data collected during an experiment: the yellow areas represent instances where the subject is stepping over the 10 × 15 cm obstacle, while the white areas are when the subject walks on level ground.

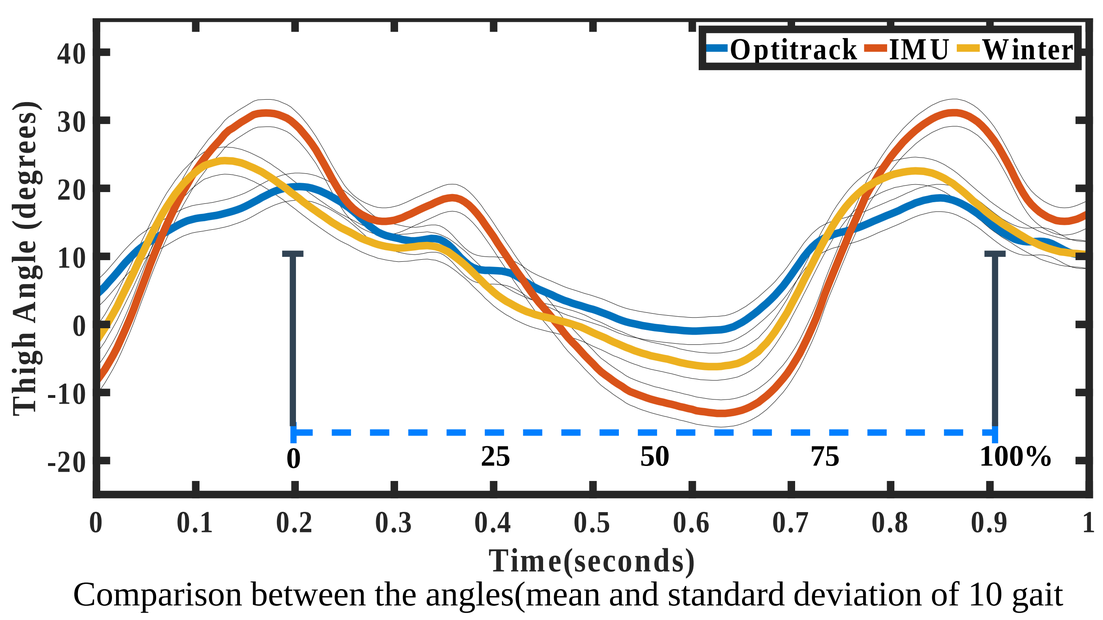
This study demonstrates that wireless data from just two IMUs—placed on both legs—**can effectively support prosthesis control** during walking and **obstacle avoidance**. Leveraging contralateral limb information improves gait interpretation and actuation timing. Integrating this approach into a **mobile phone-based system** offers a promising path toward enhanced prosthesis performance and user experience. Future work will explore real-time mobile integration and expand functional capabilities.



Thigh angle and shank angular velocity from opposite limbs of a healthy subject during level-ground walking at a preferred speed as obtained from. Point ‘A’, ‘B’,‘C’, and ‘D’, are the **reset step** point, the **step detection** point, the **stance rollover** point and the **power injection** point, respectively. Point ‘E’ corresponds to the point where the **thigh angle** reaches its **minimum** value. The plot has been shifted by 15% to demonstrate the linear nature of the thigh angle



The IMU on the left shank (imu LSH) is analogous to the IMU present on the prosthesis; the imu RTH is on the (contralateral) right thigh. The figure also shows the obstacle that the subject was asked to avoid by crossing over along with the prosthesis controlled by the algorithm. The body makers, co-ordinate systems and the optical cameras have also been shown.



Comparison between the angles(mean and standard deviation of 10 gait cycles) calculated by the control algorithm, the angles measured using the Opti track motion capture system, and the reference angles from healthy subjects [20]. The figure shows data of more that one gait cycle. 0 to 100% grading of a single gait cycle is marked using the blue line